Farnell

INCORPORATING WAYNE KERR INSTRUMENTS

Instruction/Service Manual for

Bench Power Supply

PDA3502A

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Bench Power Supply

PDA3502A

Twin Analogue Metered Power Supply
35V 2A with Independent and Tracking Modes

HANDBOOK
Part N° 9HPDA3502A

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SAFETY

GENERAL

This equipment has been designed to meet the requirements of the Farnell Safety Standard and IEC publication 348, "Safety Requirements for Electronic Measuring Apparatus", and has left the factory in a safe condition.

The remainder of this section on safety provides information and warnings which must be followed by the user to ensure safe operation and to maintain the equipment in a safe condition.

A.C. POWER SUPPLY

1) If it is necessary to fit a suitable a.c. power plug to the power cable, the user must observe the following colour codes:

LIVE terminal to BROWN lead
NEUTRAL terminal to BLUE lead
EARTH terminal to GREEN/YELLOW lead.

The user must also ensure that the protective earth lead would be the last to break should the cable be subject to excessive strain.

2) If the power cable electrical connection to the a.c. power plug is through screw terminals then, to ensure reliable connections, any solder tinning of the cable wires must be removed before fitting the plug.

3) WARNING! Any interruption of the protective earth conductor inside or outside the equipment or disconnection of the protective earth terminal is likely to make the equipment dangerous. Intentional interruption is prohibited.

4) Before switching on the equipment, **ensure that it is set to the voltage of the local a.c. power supply.**

ADJUSTMENT, REPLACEMENT OF PARTS, MAINTENANCE AND REPAIR

1) When the equipment is connected to the local a.c. power supply internal terminals may be live and the opening of the covers or removal of parts (except those to which access can be gained by hand) is likely to expose live parts. The equipment must be disconnected from all voltage sources before it is opened for any adjustments, replacement maintenance or repair.

2) Capacitors inside the equipment may still be charged even if the equipment has been disconnected from all voltage sources.

3) Any adjustment, maintenance and repair of the opened equipment under voltage must be carried out by a skilled person who is aware of the hazards involved.

4) Ensure that only fuses with the required rated current and of the specified type are used for replacement. The use of makeshift fuses and short circuiting of fuse holders is prohibited.

STATIC ELECTRICITY

The unit supplied may use static devices and service personnel should be alerted to components which require handling precautions to avoid damage by static electrical discharge.

Before handling circuit board assemblies containing these components, personnel should observe the following precautions:

1) The work surface should be a conductive grounded mat.

2) Soldering irons must be grounded and tools must be in contact with a conductive surface to ground when not in use.

3) Any person handling static sensitive parts must wear a wrist strap which provides a leaky path to ground, impedance not greater than 1 megaohm.

4) Components or circuit board assemblies must be stored in or on conductive foam or mat while work is in progress.

5) New components should be kept in the suppliers packaging until required for use.

DISPOSAL HAZARDS

Service personnel should be aware of the following:

1) Cathode ray tubes can implode if subject to excessive mechanical shock.

2) Batteries should be disposed of intact and never incinerated.

3) Beryllium oxide washers must be disposed of intact as toxic waste.

4) Many components contain polymers which will give rise to toxic fumes if incinerated.

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1. SCHEDULE OF EQUIPMENT

The Power Supply has been carefully packed to prevent damage in transit.

The complete equipment comprises:-

Description	Part Nº	Quantity
PDA3502A Power Supply.	11PDA3502A	1
IEC Mains Lead.	HC22V2	1
Shorting Link.	7SU4518	1
Handbook.	9HPDA3502A	1
Spare fuses.	FF3A005MF FT2A00123	2 of each

Note: In the event of damage in transit or shortage in delivery, separate notices in writing should be given to both the carriers and Farnell Instruments Limited, within three days of receipt of the goods, followed by a complete claim within five days. All goods which are subject of any claim for damage in transit of shortage in delivery should be preserved intact as delivered for a period of seven days after making the claim, pending inspection or instructions from Farnell Instruments, or an agent of this company.

2. INTRODUCTION

The Farnell PDA3502A is a twin output power supply with an output range for each half of 0 to 35V and 0 to 2A. Other features include :

* Constant voltage or constant current operation.

* Monitoring of voltage and current demand (when the output is off) and the 'real' voltage and current (when the output is on) by analogue displays by means of a volts/amps switch.

* Tracking mode, useful for op amp supplies where the "slave" supply tracks the voltage of the "master" and creates a plus and minus supply. Switched from the front panel.

* Fine control of output voltages by 10-turn potentiometers.

* Current settings by front panel control.

* Separate output switches.

3. SPECIFICATION

MAINS INPUT

Frequency: 50/60Hz.

Voltage Ranges: 220V or 240V ±10%
110V or 130V ±10% by factory fitted option.

Range Change: Adjustment of mains inlet fuse drawer on back panel.

Connection: Via IEC lead approx 2.0 metres long (supplied).

OUTPUT

Twin isolated outputs of 0-35V and up to 2.0 amps.

Output Modes

By switch selection, operation is possible in the following modes:-

Independent - Both outputs float completely independent of the other.

Tracking - The "-ve master" output is internally connected to the "+ve slave" output creating a centre tap. The slave output tracks the master voltage setting. The current limit is determined by the lowest setting of either master or slave. For best results a shorting link (supplied) is placed between "-ve master" and "+ve slave" to improve regulation.

Output Switches

Both outputs have an ON/OFF switch. With the switch in its OFF state, the meter displays the prospective volts and amps settings.

Output Terminals

4 mm binding posts provide the output terminals and safety earth. A shorting link is provided to connect together master and slave for the tracking mode.

Line Regulation - For a ±10% mains change from nominal.

CONSTANT VOLTAGE - Less than 0.01% + 1mV.

CONSTANT CURRENT - Less than 0.01% + 100uA.

Load Regulation - INDEPENDENT MODE

CONSTANT VOLTAGE - Less than 0.01% + 2mV (for an open circuit to full load change).

CONSTANT CURRENT - Less than 0.1% + 1mA (for a short circuit to full voltage change).

Load Regulation - TRACKING MODE with link fitted.

CONSTANT VOLTAGE - Master output less than 0.01% + 2mV (for an open circuit to full load change).
Slave output less than 0.02% + 2mV (for an open circuit to full load change).

CONSTANT CURRENT - As independent.

Output Ripple and Noise - At full load and maximum voltage
CONSTANT VOLTAGE - Less than 2mV pk-pk
CONSTANT CURRENT - Less than 0.2mA pk-pk

Temperature Coefficient
Typically 0.03% per °c

Controls
Volts control 0.02% resolution. 10 turn.
Current Control less than 0.001% resolution. Single turn log.

Transient response
250mS typical to settle for 10-100% load change.(Output does not go beyond 0.05% of nominal)
(Tracking mode 500mS typical).

Protection
i) Variable current limit.
ii) DC output fuses (accessible from underside of chassis).
iii) Reverse voltage protection by parallel diode.
iv) Forward voltage protection by diode. Maximum protection voltage 65V.

Float Voltage
The maximum dc float voltage of any terminal is 200V with respect to ground.

METERS AND INDICATORS
Twin analogue meters switched between volts and amps.

Voltmeter
fsd, 35.0 volts
Resolution 0.5V
Accuracy ± 1.5% fsd.

Ammeter
fsd, 2.0 amps
Resolution 50mA
Accuracy ± 1.5% fsd.

Indicators
"CV","CI" and "POWER" LEDs.

PHYSICAL SIZE
LENGTH - 330mm
WIDTH - 215mm
HEIGHT - 170mm
WEIGHT - 7.4kg

SAFETY

Designed to meet BS4743 (IEC348).

Isolation

Each unit is checked for insulation in the following places:-

Input (Live and Neutral linked) to Earth and Input to Output (terminals joined together and to earth) at 1500V ac to be less than 10mA. Outputs (linked together) and earth at 700V dc to be more than 10M ohm. Note:- Discharge 700V with a resistor of >500K ohm.

Environmental

Designed to meet:

Operating ambient -	0°C to +50°C (Derate power linearly above 35°C)
Storage -	-20°C to +70°C
Operating RH -	0% to 90% non condensing.

Accessories Provided

2.0 metre IEC mains lead with free end.
Handbook.
Spare fuses.
Tracking terminal link

4. INSTALLATION

4.1 SUPPLY VOLTAGE

Confirm by reference to the back panel controls that the Farnell PDA3502A is set to match the local mains supply. The power supply is normally factory set for 240V ac operation.

To change the input voltage range proceed as follows:-

a) DISCONNECT mains lead from supply.
b) Remove the fuse drawer, which is integral with the IEC socket on the back plate Replace the fuse drawer having rotated it through 180°.
c) The fuse drawer should now read the correct voltage, the right way up, either 220V or 240V. RECONNECT the IEC lead, the supply is ready for use.

NOTE: The PDA3502A unit can be factory fitted for 110V/130V operation.

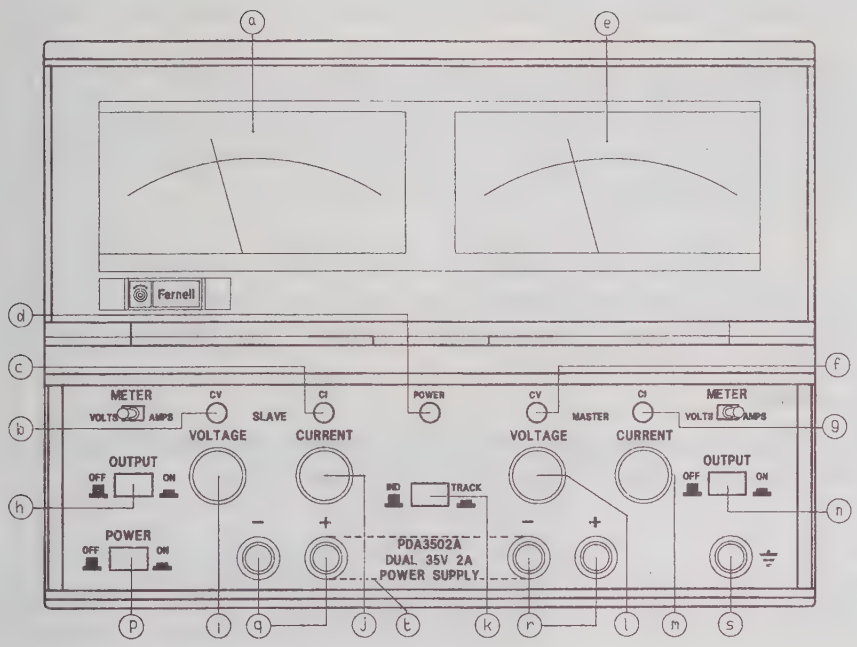
4.2 MAINS CONNECTION

The unit is provided with a mains lead terminated in a standard IEC connector at one end. The free end should be connected to a suitable plug. (Note any solder tinning of wires must be removed before connecting to the plug). The PDA3502A is classified as Safety Class 1 equipment and it is imperative that the earth lead (green/yellow) is connected to a known integrity earth, otherwise the chassis may float to a dangerous potential.

4.3 LOCATION

The Farnell PDA3502A is convection cooled. Care should be taken not to obstruct any inlet or outlet vents.

5. OPERATING INSTRUCTIONS



KEY

(a) - Slave analogue meter
(b) - Slave CV LED
(c) - Slave CI LED
(d) - Mains LED
(e) - Master analogue meter
(f) - Master CV LED
(g) - Master CI LED
(h) - Slave o/p ON/OFF swit
(i) - Slave voltage control
(j) - Slave current control
(k) - Independent/Tracking
(l) - Master voltage contro
(m) - Master current contro
(n) - Master o/p ON/OFF swi
(p) - Mains ON/OFF switch
(q) - Slave output terminal
(r) - Master output termina
(s) - Earth terminal
(t) - Tracking link

Fig 5.1 The Front Panel

5.1 FIRST TIME OPERATION

Before turning ON confirm that the unit is set to the correct mains input voltage and the correct rating of mains fuses are fitted. It is essential that the mains earth lead is connected to ground.

With both OUTPUT switches and the mains INPUT switch set to OFF connect to the local mains supply.

Select independent operation, and turn current and voltage controls fully anticlockwise.

Depress the mains input switch to ON and note that each meter displays zero. By selecting volts using the "volts/amps" switch and rotating the voltage control clockwise the required output voltage can be set. By selecting amps and rotating the amps control clockwise the prospective current limit point can be set.

Depress the output switch and note that the amps display has reduced to zero to indicate that no current is flowing. The yellow CV led will be illuminated indicating that the unit is in constant voltage mode.

The unit is now ready for use.

NOTE: When connecting a load the general rule is to use a wire gauge greater than the minimum necessary to carry the current, in order to maintain adequate regulation at the load.

5.2 SETTING VOLTAGE AND CURRENT WITH THE LOAD CONNECTED

A feature of the Farnell PDA3502A is that both the voltage and current levels can be set without the need to disconnect the load. When the output switch is OFF the display previews the output settings and is indicated by both the CV and CI leds being OFF.

Upon depression of the output switch the load is electrically connected to the power supply and the meter gives either indication of voltage or current flowing. The yellow CV and red CI leds indicate whether the output is driven in constant voltage or constant current modes respectively.

5.3 CV AND CI OPERATION

The PDA3502A provides automatic changeover from CV (Constant Voltage) to CI (Constant Current), with status indication provided by yellow and red LEDs.

Constant Voltage mode -
The CV mode of operation is the more usual, where the power supply delivers Constant Voltage until such times as the load current demand exceeds the current limit setting.

Constant Current mode -
At this point, the power supply operates in CI and the output voltage falls to a level dependent upon the load current demand. On removal of the overload (ie. load demand less than current limit setting) the power supply reverts to CV operation.

NOTE: Although the current control can be used to limit the dc current in the range from maximum down to 0.1% of maximum, it must be remembered that the instantaneous current is independent of any such setting. This is due to the output capacitor, which is needed to stabilise the output. The instantaneous current is thus a function of output voltage, capacitance value, lead and source impedance and the load impedance.

5.4 MODES OF OPERATION

The Farnell PDA3502A can be switch selected to provide two different modes of operation :-

Independent

In this mode each output is completely isolated from the other with independent control of voltage, current and output ON/OFF.

Tracking

In this mode the outputs are internally connected in series, "+ve slave" terminal to the "-ve master" terminal. Output can be taken from across "-ve slave" and "+ve master" to give upto 70v or separately across each individual output to provide a centre tap and a positive and negative supply, (the master being positive). The slave voltage control becomes redundant and all voltage control is done by the master. The slave tracks the master to give an identical output voltage. The current controls continue to work independently.

With the slave output switched OFF the slave voltmeter displays zero. The preset voltage on the slave is that displayed on the master meter. The slave voltmeter displays the actual voltage when the slave output is turned ON.

NOTE: For improved output regulation place the shorting link provided between "+ve slave" and "-ve master".

5.5 EARTHING THE LOAD

As supplied, each output is floating from chassis (safety earth) and can be floated up to a maximum dc potential of 200V dc (including output volts) from chassis.

If desired either the +ve or -ve terminal can be connected to the green earth terminal to provide an output negative or positive with respect to chassis.

6. CIRCUIT DESCRIPTION

The PDA3502A power supply is made up of a mains step down transformer, DC rectifying components, a series of regulator transistors and the associated control circuitry, including analogue meters, resulting in a twin smoothed DC output of 35 volts at upto 2 amps.

6.1 THE MAINS RECTIFIER CIRCUIT Circuit diagram : 2SZX0703

Raw mains is supplied to the primary input of a mains toroid via a front panel operated mains switch (SW101). The live input is fuse protected by F101, which is interchangeable between the 220v and 240v ac inputs. The toroid TX101 provides secondary voltages, 47v for the series regulators and 22v for the control circuitry.

6.2 THE CONTROL CIRCUIT Circuit diagram : 2SZX0703

The control board is made up of two almost identical circuits so for the sake of the general description the MASTER side will be considered only.
NOTE.The Tracking facility incorporates both sides of the circuit and will be explained later in this description.

Bridge rectifier BR2 and reservoir capacitors C17 and C18 provide unregulated DC from one secondary tap, the positive feeding the master series regulator, whilst the negative is taken via a protection fuse F102 to the negative output terminal of the master. The secondary output is tap changed by relay RL2 between either 23.5v or 47v unregulated DC. The changeover occurs as the output from the power supply goes across the halfway point. This is done so that the dissipation from the series regulator transistors is kept to a minimum and to make the unit more efficient. The relay is controlled by U10 which acts as a comparator. If the output goes above half way (≈17V) the output of U10 goes high and prevents Q6 from turning on. This in turn keeps Q7 off and RL2 in the normally closed position which provides a path for the 47v secondary tap onto BR2. If the output from the power supply is less than half, the output of U10 is low, Q6 and Q7 are turned on and RL2 is switched to the normally open position so that the 23.5v secondary tap is connected to BR2. A small hysteresis is created by R81 so that the relay does not "chatter".

The series regulator's output is taken via emitter sharing resistors through the current monitoring parallel resistors R64-R68 to the output ON/OFF switch SW2 which interrupts the feed to the positive terminal. Since the series regulator transistors are responsible for the bulk of heat dissipation, they are mounted on heatsinks in the rear of the unit.

The master control circuit is supplied from one 22v tap on the toroid TX101. This AC voltage is halfwave rectified by D7, smoothed by C20 and C22 and regulated to 15v DC by U5. The resultant smoothed supply is fed across R33, Z4 and Z5 to provide a +10.3v line, 0v and -4.7v. The junction of R33 and Z4 provides a further nominal positive 5.6v reference line. A "POWER" indication LED and series resistor are directly across the positive and 0v lines. An LM358 dual operational amplifier (U6) is used in the current and voltage loops. The inverting input of U6-A is taken to the negative of the reference zener Z4 and forms the positive sense line. The front panel voltage control potentiometer, P5, is connected across Z4 and feeds a

variable proportion of the reference to the top end of a potential divider formed by R34 and R35. The junction of R34 and R35 is connected to the non-inverting input of the voltage loop side of U6, with the bottom end of the divider chain forming the negative sense line. The operational amplifier will endeavour to keep the junction of R34 and R35 and the positive sense line at the same potential, hence the output voltage is given by :

$$V1 \times \frac{R35}{R34}$$

Where V1 is the voltage at the wiper of the front panel voltage control potentiometer, P5.

U6-B forms the current loop operational amplifier and a further 5.6v zener Z6 creates the reference voltage. The single turn current control potentiometer is connected across Z6 via a divider chain R49 and R50 to give 1-430mv on the non-inverting input of U6-B.(The voltage is prevented from going to absolute zero by R51).The inverting input of U6 is connected to the positive side of the parallel current monitoring resistors, the negative side of these being connected to the negative end of Z6. A voltage is developed across these sense resistors (2 amps equivalent to 400mv) which is compared with the reference voltage and so prevents the current drawn from being more than 2.15 amps. As long as the voltage across the sense resistors is less than the reference voltage on the non-inverting input, D10 is reversed biased and control is maintained by the voltage loop. As soon as the sense voltage equals the reference voltage the output pin of U6-B goes low and becomes a current sink forward biasing D10 and pulling down the base of the series regulator driver transistor Q3. This holds the output current constant until either the reference voltage is increased or the load is decreased. Once this happens the unit automatically returns to the constant voltage mode.

If the output of U6-B is low, the non-inverting input of U7-A is at a lower state than that of the inverting input (0V).The output of the op-amp is low and acts as a current sink for the "CI" LED and so illuminates it. If the output of U6-B is high then the output of U7-A is high. The op-amp then sources current through the "CV" LED to 0V and illuminates it. U8-A is controlled by the output switch and gates the current path for the LEDS so that they only work when the output is on.

U8-B is also controlled by the output switch. This selects the path for the VOLTS / AMPS meter current so that the meter can read the demand current when the output is off and the actual current flowing when the output is on. U7-B is in the circuit to decrease the impedance for the meter. The meter is connected to the positive sense line prior to the output switch and is referenced to the negative sense line so permanently reads the voltage on the output, provided the 'volts/amps' switch is set to VOLTS.

6.3 THE TRACKING MODE CIRCUIT Circuit diagram : 2SZX0703

In tracking mode the negative master output is internally connected to the positive slave output creating a centre tap. The slave voltage loop operational amplifier U2-A is now no longer controlled by the front panel voltage control potentiometer P1 but by the master positive sense voltage referenced to the slave negative sense. The junction of R62 and R5 is connected to the non-inverting input of U2-A and as these two resistors are the same value the slave output follows the master and gives exactly half the output of that between negative slave and positive master outputs.

NOTE: Fit the link provided between the negative master and positive slave outputs when using the TRACKING mode. Without the link fitted, the supply will function as normal but load regulation will increase as the INDEPENDENT/TRACKING switch provides the connection between negative master and positive slave instead.

6.4 POTENTIAL MAP

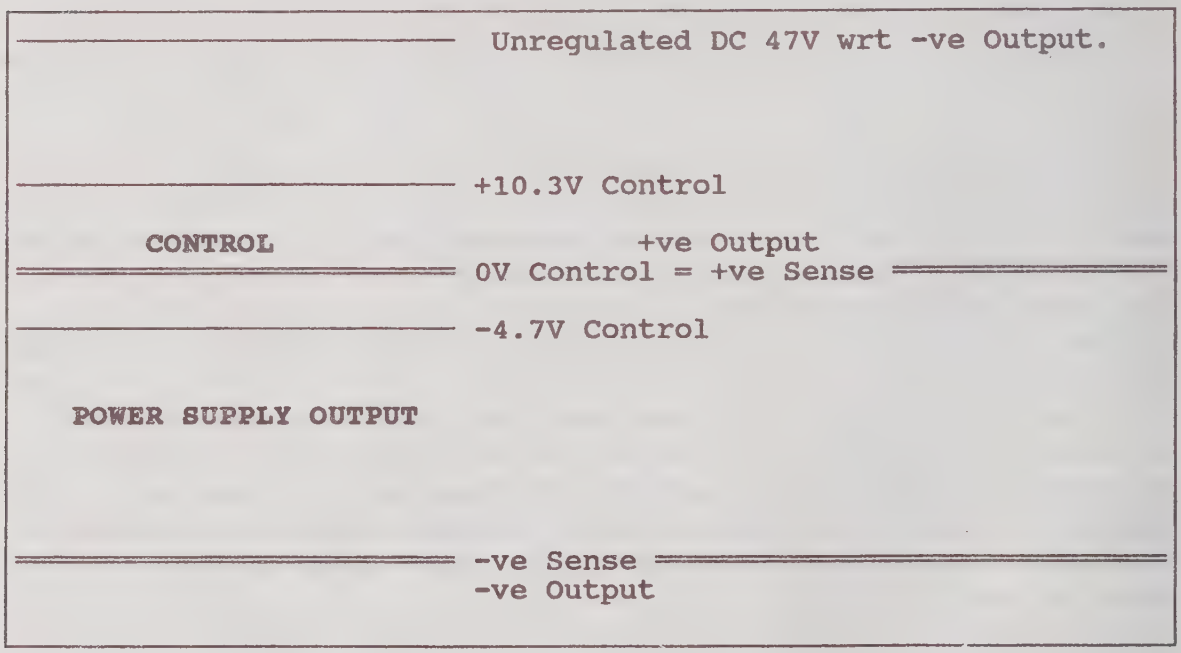


Fig 6.1 Potential Map

7. MAINTENANCE AND RECALIBRATION

7.1 MAINTENANCE

The Farnell PDA3502A is designed as a minimum maintenance product.

Recommended maintenance is limited to the removal of dust from within the unit and heatsink area by blowing and brushing. Periodically the outside of the unit can be wiped with a cloth dampened with a mild detergent. If preventative maintenance is required then we recommend after 5,000 hours operation that all fuses are replaced.

Gaining Access to the PDA3502A

WARNING! Isolate unit from mains supply and disconnect any load from the output terminals. Remove the cover by first removing the six cross head screws retaining the cover from underneath the chassis. Replace the unit on it's feet and remove the two cross head screws retaining the cover handle. Slide the cover towards the rear of the unit and gently lift off by springing out the bottom of the sides.

7.2 RECALIBRATION

WARNING! This operation must only be carried out by qualified personnel who are conversant with working on *live equipment*. The engineer must ensure that he takes all required precautions to protect himself and others from any hazard.

If required the PDA3502A can be returned to Farnell Instruments Limited or their agents for repair and recalibration.

Display Recalibration

EQUIPMENT REQUIRED - 4½ Digit voltmeter @ 35V
Adjustable 15-20Ω Load @ 2A
3½ Digit ammeter @ 2A

1) Two potentiometers for each display can be adjusted from above on the Control board using an insulated trimming tool once the cover has been removed.

   Master display - P7 AMPS ; P8 VOLTS
   Slave display - P3 AMPS ; P4 VOLTS

2) Set the mode select switch to 'Independent' and ensure that the output switches are 'OFF'. Turn the voltage control potentiometers to approximately 35 volts, and the current control potentiometers fully clockwise.

3) Connect the master output to a load capable of handling 2 amps with a ammeter of known accuracy in series with the -ve terminal. Set the load to approx 17.5Ω to draw 2.00A from the PDA3502A unit. Set the ammeter display needle to line up with 2.0A using P7. Turn the current control potentiometer anticlockwise and ensure the unit goes into constant current mode indicated by the 'CI' LED illuminating replacing the 'CV' LED. Repeat for the slave output using P3. Switch the outputs off and disconnect the load.

4) Turn the volts potentiometer on the master to achieve 35.00 volts output using the DVM. Trim the voltage display with P8 to line up the needle against 35V. Repeat with the slave output and pot P4. Ensure for these tests that the CV LED is on.

5) Replace the cover and screws.

7.3 GUARANTEE

The equipment supplied by Farnell Instruments Limited is guaranteed against defective material and faulty manufacture for a period of twelve months from the date of dispatch. In the case of material or components employed in the equipment but not manufactured by us, we allow the customer the period of any guarantee extended to us.

The equipment has been carefully inspected and submitted to comprehensive tests at the factor prior to dispatch. If, within the guarantee period, any defect is discovered in the equipment in respect of material or workmanship and reasonably within our control, we undertake to make good the defect at our own expense subject to our standard conditions of sale. In exceptional circumstances and at the discretion of the Service Manager, a charge for labour and carriage costs incurred may be made.

Our responsibility is in all cases limited to the cost of making good the defect in the equipment itself. The guarantee does not extend to third parties, nor does it apply to defects caused by abnormal conditions, accident, misuse, neglect or wear and tear.

In the event of difficulty, or apparent circuit malfunction, it is advisable to telephone (or telex) the Service department or your local Sales Engineer or Agent (if overseas) for advice before attempting repairs.

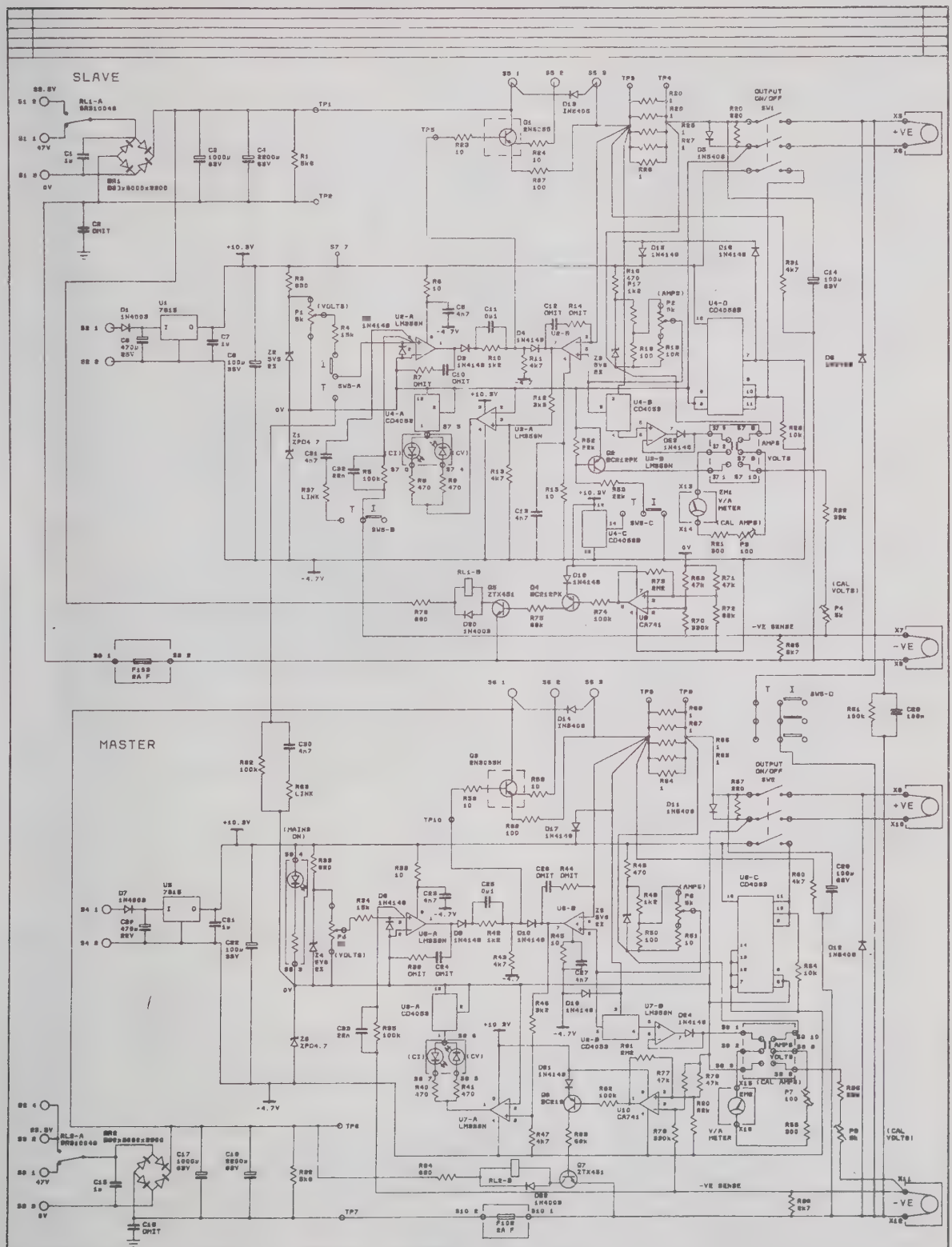
For repairs and recalibration if is recommended that the complete instrument be returned to:-

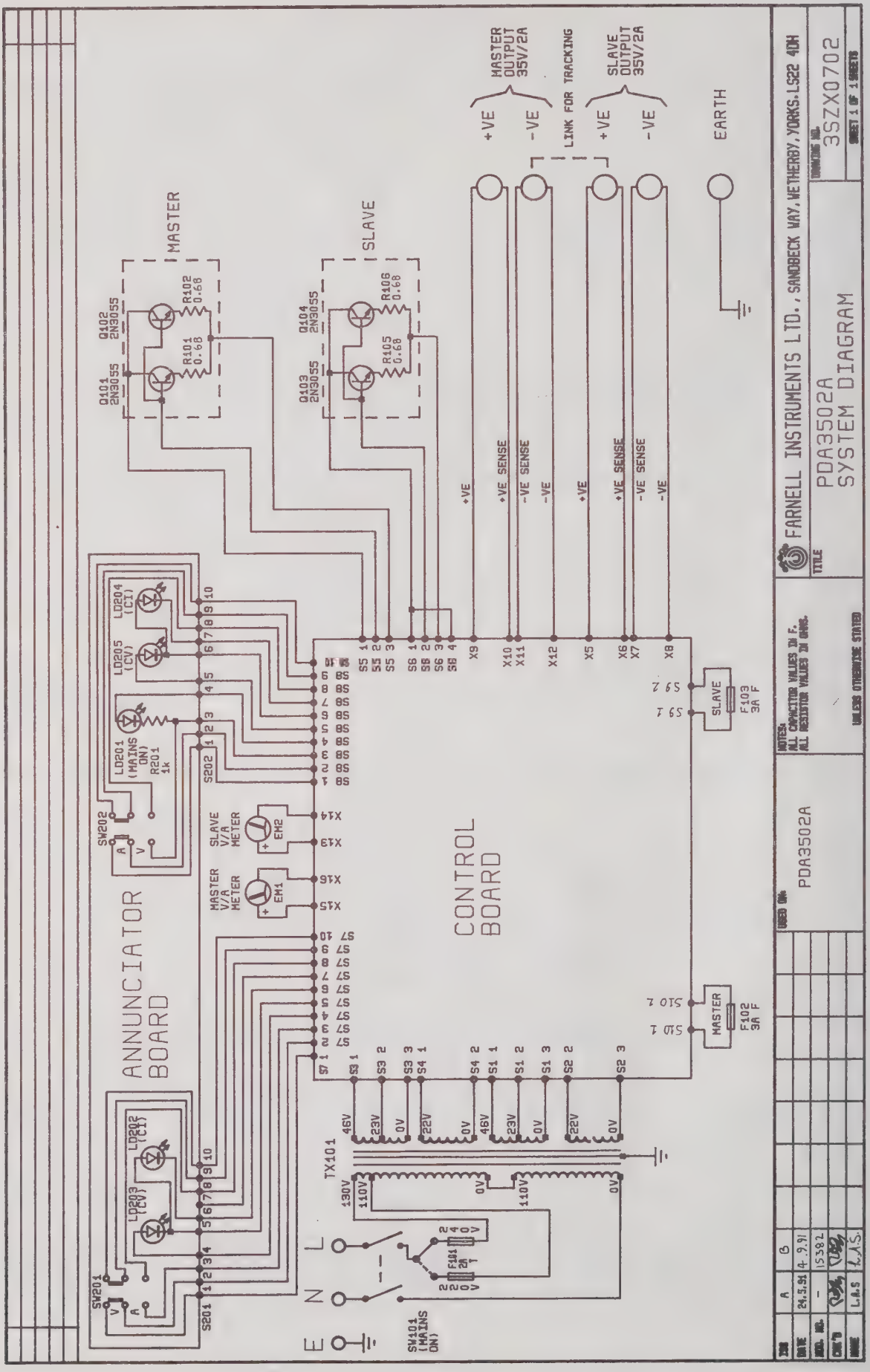
The Service Department
Farnell Instruments Ltd.
Osborn House
Sandbeck Way
Wetherby
West Yorkshire
LS22 4DN

TEL: (0937) 581961 TELEX: 557294 FAX: (0937) 586907

Please ensure adequate care is taken with packing and arrange insurance cover against damage or loss.

8. CIRCUIT DIAGRAMS




ANNUNCIATOR BOARD
CONTROL BOARD
MASTER
SLAVE
Q101 2N3055
Q102 2N3055
Q103 2N3055
Q104 2N3055
R101 0.68
R102 0.68
R105 0.68
R106 0.68
LD201 (MAINS ON)
R201 1k
LD202 (CI)
LD203 (CV)
LD204 (CI)
LD205 (CV)
SW201
SW202
SW101 (MAINS ON)
TX101
F101 2A
F102 3A F
F103 3A F
MASTER V/A METER
SLAVE V/A METER
EM1
EM2
+VE
-VE
+VE SENSE
-VE SENSE
LINK FOR TRACKING
MASTER OUTPUT 35V/2A
SLAVE OUTPUT 35V/2A
EARTH
FARNELL INSTRUMENTS LTD., SANDBECK WAY, WETHERBY, YORKS. LS22 4DH
PDA3502A
SYSTEM DIAGRAM
3SZX0702
PDA3502A
UNLESS OTHERWISE STATED

Farnell Instruments Ltd

Component Schedules

Date: 11/11/91

Unit Item No: PDA3502A Description: BENCH P/S 0-35V/2A TWIN O/P

Important explanation - Please read before ordering parts.
Due to limitations in the number of character spaces available the information in the circuit reference field has been abbreviated and the following notes are provided as a guide to its interpretation.

1. Where a component is used more than once on an assembly the alphabetic portion of the circuit reference for its second and subsequent locations has been omitted; eg. the circuit reference information for a component located at R1 and R6 will appear as: R1 6

2. The circuit reference numbers are presented in ascending decade blocks delimited by colons; second and subsequent numbers within a decade block represent only the unit value of the location (the tens and hundreds values being implied); eg. for a component located at R54, R57, R59, R82, R82, R87, R102, R110 and R112 the circuit reference entry will be: R54 7 9:82 7 9:82 7:102:10 2.

3. Where components are used in a series of neighbouring circuit reference locations the circuit reference numbers are represented as inclusive blocks using a hyphen; eg. for a component located at R16, R19, R21, R24, R25, R26, R31, R37, R38, R39, R40, R44, and R46 will be represented as R16 9:21 4-6: 31 37-40 4 6 (An exception to the rules occurs when a series crosses a decade block in which case the tens value is inserted.

4. Comments are preceded by a semicolon.

When ordering replacement parts please be sure to quote the part number provided.

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
2EAPDA3502A	BENCH P/S 0-35V/2A TWIN O/P		A	1.000	
31PDA	PDA3502A CASING		A	1.000	3
7SU4504	COVER.....	1SUTE4504	A	1.000	
8L034201	SERIAL NUMBER LABEL	3SQ034201	A	1.000	
HA04517	WHITE HANDLE	3SU004517	A	1.000	
HC22V2	PLUG & LEAD 22/V/2	22-V-2		1.000	
HM0108	END MOULDING	3SV0108	A	2.000	
HR0514	L30 HANDLE RET	ASUAE0514	A	2.000	
4NPDAFP	FRONT PANEL ASM		A	1.000	4
5NPDACB	PDA3502A CONTROL CB ASM		A	1.000	5
5NPDACBA	PDA3502A CONTROL AXIAL		A	1.000	5
BC1534	PDA CONTROL BOARD	1N1SBM15340	C	1.000 1	
DG4003	DIODE	1N4003		5.000 1	10 D1 7:19:20 2

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
DG4148	DIODE	1N4148		13.000 1	10 D2-4 8-10 15-18:21 3 4
DZ14V70E	4.7V 5% 0W50	ZPD4.7		2.000 1	10 Z1 5
DZ15V60E	5.6V 2% 0W50	ZPD5.6		4.000 1	10 Z2-4 6
RAOMIT	RESISTORS OMITTED	RAOMIT		4.000 1	R7:14:38:44
RG72M20BJ	2M20 5% 0W25 250PPM 1K1V	VR25		2.000 1	10 R73:81
RM11R00FF	1R00 1% 0W60 100PPM 250V	MRS25		10.000 1	10 R26-30:64-68
RM210R0FF	10R0 1% 0W60 50PPM 250V	MRS25		10.000 1	10 R6:15 9:24 5:39:45:51 8 9
RM3100RFF	100R 1% 0W60 50PPM 250V	MRS25		4.000 1	10 R18:50:87 8
RM3220RFF	220R 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R20:57
RM3300RFF	300R 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R21:55
RM3470RFF	470R 1% 0W60 50PPM 250V	MRS25		6.000 1	10 R8 9:16:40 1 8
RM3680RFF	680R 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R76:84
RM3820RFF	820R 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R3:33
RM41K00FF	1K00 1% 0W60 50PPM 250V	MRS25		1.000 1	10 R201
RM41K20FF	1K20 1% 0W60 50PPM 250V	MRS25		4.000 1	10 R10 7:42 9
RM42K70FF	2K70 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R85 6
RM43K30FF	3K30 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R12:46
RM44K70FF	4K70 1% 0W60 50PPM 250V	MRS25		6.000 1	10 R11 3:31:43 7:60
RM45K60FF	5K60 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R1:32
RM510K0FF	10K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R23:54
RM515K0FF	15K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R4:34
RM522K0FF	22K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R52 3
RM533K0FF	33K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R22:56
RM547K0FF	47K0 1% 0W60 50PPM 250V	MRS25		4.000 1	10 R69:71 7 9
RM568K0FF	68K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R75:83
RM582K0FF	82K0 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R72:80
RM6100KFF	100K 1% 0W60 50PPM 250V	MRS25		5.000 1	10 R5:35:62:74:82
RM6100KGF	100K 1% 1W00 50PPM 500V	SMA0411S		1.000 1	R61
RM6330KFF	330K 1% 0W60 50PPM 250V	MRS25		2.000 1	10 R70 8
YT22	T/C WIRE 22SWG	22SWG		1.000 1	10 LK1-37 R37:63
5NPDACBR	PDA3502A CONTROL RADIAL		A	1.000	5
CAOMIT	CAPACITORS OMITTED			6.000 2	C2:10 2 6:24 6
CEC100UHM	100UF 20% 35V R050	KMVB		2.000 2	C8:22
CEC470UGM	470UF 20% 25V R050	KMVB		2.000 2	C6:20
CEC470UKM	470UF 20% 63V R050	KMVB		2.000 2	C14:28
CR44N70LM	4.7NF 20% 100V R050	FKS2		6.000 2	C9:13:23 7:30 1
CR522N0KM	22NF 20% 63V R050	MKS2MIN		2.000 2	C32 3
CR6100NKM	100NF 20% 63V R050	MKS2MIN		2.000 2	C11:25
CR6100NSK	100NF 10% 400V R150	368-51104		1.000 2	C29
CRA1U00KM	1.0UF 20% 63V R100	MKS4		2.000 2	C1:15
CRA1U00KM1	1.0UF 20% 63V R050	MKS2		2.000 2	C7:21
LD2E401	LED SPACER S2E/4/01	LEDS2E-4-01		5.000	LD201-5
LD5FTGN	LED GREEN 5MM FLAT TOP	LTL-2233A		1.000	LD201
LD5FTRD	LED RED 5MM FLAT TOP	LTL-2223A		2.000	LD203 5
LD5FTYL	LED YELLOW 5MM FLAT TOP	LT-2253A		2.000	LD202 4
PM3100RKV	100R 10% PRESET VERT STURN	63P		2.000 2	P3 7
PM45K00KV	5K00 10% PRESET VERT STURN	63P		2.000 2	P4 8
VA358N	IC LM358N NSC ONLY	LM358N		4.000 2	U2 3 6 7
VA741CG	IC CA741CE	CA741CE		2.000 2	U9:10
VD4053B	IC CD4053B STATIC	CD4053B		2.000 2	U4 8
VT212PKCR	BC212PK TO5 JOG/CROP	BC212PK35		3.000 2	Q2 4 6
VTX451K	ZTX451 60V 1A TO92 N	ZTX451+(4SC0174)		2.000 2	Q5 7

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
7SU4523	CONTROL BKT....	3SUCB4523	A	1.000 3	
CED1M00KM	1.0MF 20% 63V R075	KMVB		2.000 3	C3:17
CED2M20KM	2.2MF 20% 63V S100	ALC20A222BD063		2.000 3	C4:18
DBB80	BRIDGE RECTIFIER 25MM LEADOUTS	B80C/5000/3300		2.000 3	BR1 2
DG5408	DIODE	1N5408/P300M		6.000 3	D5 6:11-14
HC0250	JUMPER LEAD 10W 100MM LONG	4SC0250	A	2.000	S201 2
HST0220	H/SINK TO220	TO220+PB136CB		2.000 3	Q1 3
MM103C	TRANSISTOR MICA TO220	MI6108		2.000	
PM0244	5K0R 10% LOG S/TURN	4SC0244	A	2.000 3	P2 6
PW0243	5K0R 5% LIN M/TURN	4SC0243	A	2.000 3	P1 5
SB0093	PUSH BUTTON (4ST0093)	F6UEE(4ST0093)	A	1.000	SW5
SB5020	MAINS SWITCH 6 WAY	PBMS5020		2.000 3	SW1 2
SR310048	RELAY 48V 16AMP	RP310	A	2.000	RL1 2
STTL46	TINY TOGGLE SWITCH DPCO	TL46P0055		2.000	SW201 2
TAOMIT	SOCKETS,PLUGS OMITTED	TAOMIT		10.000	TP1-10
TBA3903PSS	3W PIN WAFER FRICTION LOCK SQU	640445-3		3.000	S1 5 6
TBA3904PSS	4W PIN WAFER FRICTION LOCK SQU	640445-4		1.000	S3
TBA7902PSS1	3W PIN 2VOID FRICTION LOCK SQ	640445-3		2.000 3	S9:10
TBM2502PS	STRAIGHT PIN HEADER 2 WAY 2.54	6410+22-27-2021		2.000 3	S2 4
VA7815CT	IC MC7815CT	MC7815CT		2.000 3	U1 5
VT3055T	TRANS MJE3055T	MJE3055T		2.000 3	Q1 3
7SU4213	METER MTG PLATE	3SUBS4213	A	1.000	
7SU4515	FRONT PANEL.....	3SUSF4515	A	1.000	
7SU4518	TRACKING LINK....	4SUCJ4518	A	1.000	
EM0020	METER "P"SERIES	3SM0020	A	2.000	EM1 2
HK0246	"P" SERIES KNOB BEIGE	4SC0246	A	4.000	
HK0248	"P" SERIES KNOB BEIGE	4SC0248	A	4.000	
UHM0100	FRONT MOULDING "P"SERIES	1SV0100	A	1.000	
HL70X210	PROTECTIVE FILM 70 X 210	164+TRANS-POLYTHENE		1.000	
HM0102	BLANKING STRIP "P"SERIES	3SV0102	A	2.000	
HM0103	LENS MOULDING "P"SERIES	2SV0103	A	1.000	
HM0104	PUSH ROD "P"SERIES	3SV0104	A	1.000	
HM0106	DOUBLE FRONT BEZEL A	2SV0106	A	1.000	
SA0249	SWITCH BUTTON "P" SERIES	4SC0249	A	4.000	
TC1418782	FASTON TAB .25" DOUBLE	141878-2		4.000	
TM0245	TP2 TERMINAL GREY/RED	4SC0245	A	2.000	
TM0251	TP2 TERMINAL GREY/BLACK	4SC0251	A	2.000	
TM2EGRN	TERMINAL GREEN	TP2E+(GREEN)		1.000	
4NPDATX	PDA3502A MAINS BOX ASM		A	1.000	4
7SU4498	MAINS HOUSING	2SUCB4498	A	1.000	
7SU4503	HEATSINK SUPPORT	2SUCB4503	A	1.000	
FH19276	FUSE HOLDER / VOLTAGE SELECTOR	CL19276		1.000	F101
FT2A00123	FUSE 2 AMP ANTI-SURGE	S502		1.000	F101
SB5040	MAINS SWITCH 4 WAY	PBMS5040		1.000	SW101
TK192710	IEC INLET SOCKET	CL192710		1.000	F101
TV19285	IEC INLET SHROUD	CL19285		1.000	F101
ZR0334	TORROID EAPDA 3502A	3SR0334	A	1.000	TX101
6P10064	ZR0334 WIRE PREP		A	1.000	6
TBA3903HS	3W HOUSING WITH STRAIGHT LOCK	640250-3		1.000	
TBA3903HS	4W HOUSING WITH STRAIGHT LOCK	640250-4		1.000	
TBM2502HP	CRIMP HOUSING 2 WAY 2.54MM	6471+22-01-2025		2.000	
YP1602BKV	BLACK 16/0.2 VX	VX350		0.260	

FARNELL PART NUMBER	DESCRIPTION	MANF PART NO	ISS	QTY	COMPONENT REFERENCE
YP1602BLV	BLUE 16/0.2 VX	16/0.2+VX		0.420	
YP1602BNV	BROWN 16/0.2 VX	16/0.2+VX		0.210	
YP1602ORV	ORANGE 16/0.2 VX	16/0.2+VX		0.160	
YP1602RDV	RED 16/0.2 VX	16/0.2+VX		0.530	
YP1602VIV	VIOLET 16/0.2 VX	16/0.2+VX		0.210	
YP1602WHV	WHITE 16/0.2 VX	16/0.2+VX		0.320	
YP2402GNV	GRNYEL 24/0.2 VX	24/0.2+VX		0.110	
YP702VIV	VIOLET 7/0.2 VX	7/0.2+PVC		0.520	
4SPDHS	PDA/PDD 3502A HEATSINK ASM		A	2.000	4
7SU4506	HEATSINK A.....	3SUBA4506	A	1.000	HEATSINK A
7SU4507	HEATSINK B.....	3SUBA4507	A	1.000	HEATSINK B
7SU4508	HEATSINK C.....	3SUBA4508	A	1.000	HEATSINK C
MC1	CERAMIC BEAD SMALL	IPB/1		8.000	
MM3055	TRANSISTOR MICA TO3	DF377A		2.000	
RW0R680JJ	OR68 5% 2W50	74ER		2.000	R101 2 OR R105 6
VT3055S	SEMELAB COMP ONLY	2N3055		2.000	Q101 2 OR Q103 4
6P10075	PDA3502A		A	1.000	6
TBA3903HS	3W HOUSING WITH STRAIGHT LOCK	640250-3		4.000	
TC1547181	FASTON RECEPTACLE .25"	154718-6		8.000	
TC154719	FASTON BOOT .25" BLACK	154719		8.000	
YP1602BLV	BLUE 16/0.2 VX	16/0.2+VX		0.160	
YP1602BNV	BROWN 16/0.2 VX	16/0.2+VX		0.160	
YP1602ORV	ORANGE 16/0.2 VX	16/0.2+VX		0.360	
YP1976GN	GREEN 19/0076 PTFE	19/0076+PTFE		0.480	
YP1976OR	ORANGE 19/0076 PTFE	19/0076+PTFE		0.540	
YP1976PK	PINK 19/0076 PTFE	19/0076+PTFE		0.440	
YP2402BKV	BLACK 24/0.2 VX	24/0.2+VX		0.740	
YP2402RDV	RED 24/0.2 VX	VX450		0.740	
YPF18GNY	GRNYEL UL3266 19/0.25	19/0.25+UL3266		0.340	
7SU4499	HANDLE SUPPORT	3SUCB4499	A	1.000	
7SU4505	CHASSIS.....	1SUCB4505	A	1.000	
8L0312	PATENT PROTECTION LABEL	4SQ0312	A	1.000	
FF3A005MF	FUSE 3 AMP QUICK BLOW	5MF/3A		2.000	F102 3
FH520TP	FUSE HOLDER 5 X 20MM P/MTG	FH333		2.000	F102 3
GC2643	BLANKING PLUG 1/2"	2643		1.000	
HFSTD	FOOT 103-E119700	103-E1197-00		4.000	
HL9X30	BLANK 9X30 P120	P120		1.000	
HM0109	LINK "P"SERIES	4SV0109	A	1.000	
HW4205	FIXING PLATE	4SUCB4205	A	3.000	
HW4496	LINK ROD "P" SERIES	3SUCB4496	A	1.000	

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